Supplementary Materials

The correlates and dynamics of COVID-19 vaccine-specific hesitancy

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Supplementary Tables

Table S1. Demographic Breakdown of Sample

	Census	Pooled	Wave 1	Wave 2	Wave 3
Female	51.4	52.0	51.2	53.1	51.6
18-34	27.3	26.4	27.1	25.8	26.1
34-54	34.1	34.1	33.6	34.5	34.4
55+	38.6	39.5	39.3	39.8	39.4
French	21.4	20.2	20.8	19.2	21
Atlantic	6.8	6.6	6.8	6.8	6.1
Quebec	23.4	23.2	23.5	22.6	23.8
Ontario	38.3	38.4	38.1	38.7	38.6
West	31.2	31.7	31.5	31.9	31.6

Table S2. Covariate Measurement

Covariate	Measurement
COVID-19 Vaccination Intention	Would take a COVID-19 vaccine if available (Yes, No, Unsure)
Anti-intellectualism	Trust in the following groups: experts, doctors, medical professionals, scientists, university professors, economists (distrust a lot, distrust somewhat, neither trust nor distrust, trust somewhat, trust a lot; 0-1 index)
Support for Childhood Vaccination	Level of agreement or disagreement with the following statements: 1) Childhood vaccines are important for the health of children; 2) Getting vaccines is a good way to protect children from disease; 3) Having children vaccinated is important for the health of others in my community; 4) All childhood vaccines offered by the government in my community are beneficial; 5) The information I receive about vaccines from the government is reliable and trustworthy; 6) Generally I do what my doctor or health care provider recommends about vaccines (strongly agree/disagree, somewhat agree/disagree, or neither agree nor disagree; 0-1 index)
COVID-19 Risk Perceptions	How serious of a threat is COVID-19 to 1) yourself; 2) other Canadians? (very serious, somewhat serious, not very serious, not at all serious; 0-1 index)
COVID-19 News Exposure	How often in the past week have you read, watched, or listened to news related to the COVID-19 pandemic (never, once, a few times, almost every day, daily, and several times a day)

Table S3. Figure 1 Coefficient Estimates

	Intention		Effectiveness		Safety	
	Coef.	SE	Coef.	SE	Coef.	SE
Moderna	-0.04***	0.01	-0.03***	0.01	-0.03***	0.01
AstraZeneca	-0.19***	0.01	-0.13***	0.01	-0.14***	0.01
J&J (Wave 2 and 3)	-0.11***	0.01	-0.11***	0.01	-0.08***	0.01
Wave 2	0.00	0.01	0.02***	0.01	0.01	0.01
Wave 3	-0.04***	0.01	0.01	0.01	-0.03***	0.01
Constant	0.78***	0.01	0.75***	0.01	0.75***	0.01
R	0.05		0.04		0.04	
N	6248		6248		6248	

HC2 robust standard errors; * $p<0.1$, ** $p<0.05$, *** $p<0.01$. Note: J&J = Johnson & Johnson treatment.

Table S4. Figure 2 Coefficient Estimates

	Intention		Effectiveness		Safety	
	Coef.	SE	Coef.	SE	Coef.	SE
Moderna	-0.02	0.02	-0.01	0.01	-0.02	0.01
AstraZeneca	-0.10***	0.02	-0.09***	0.01	-0.06***	0.01
J&J (Wave 2)	-0.26***	0.03	-0.17***	0.02	-0.19***	0.02
Wave 2	0.05***	0.02	0.05***	0.01	0.05***	0.02
Wave 3	0.08***	0.02	0.06***	0.02	0.06***	0.02
Moderna * Wave 2	-0.04	0.02	-0.02	0.02	-0.01	0.02
Moderna * Wave 3	-0.08***	0.03	-0.04*	0.03	-0.04	0.03
AstraZeneca * Wave 2	-0.12***	0.02	-0.08***	0.02	-0.13***	0.02
AstraZeneca * Wave 3	-0.23***	0.03	-0.09***	0.03	-0.17***	0.03
J&J * Wave 3	0.17***	0.03	0.07***	0.03	0.13***	0.03
Constant	0.74***	0.01	0.73***	0.01	0.72***	0.01
R^2	0.06		0.04		0.05	
N	6248		6248		6248	

HC2 robust standard errors; * $p<0.1$, ** $p<0.05$, *** $p<0.01$. Note: J&J = Johnson & Johnson treatment.

Table S5. Figure 3 Coefficient Estimates

	Coef.	SE	Coef.	SE
Effectiveness	0.43***	0.03	0.41***	0.04
Safety	0.57***	0.03	0.59***	0.04
Wave 2	-0.01	0.01	-0.02	0.02
Wave 3	-0.02	0.02	0.06**	0.03
Wave 2 * Effectiveness	-0.04	0.04	0.02	0.06
Wave 3 * Effectiveness	-0.13**	0.06	0.02	0.07
Wave 2 * Safety	0.05	0.04	-0.01	0.06
Wave 3 * Safety	0.13**	0.05	-0.08	0.07
AZ/J&J			-0.01	0.02
AZ/J&J * Effectiveness			0.03	0.07
AZ/J&J * Safety			-0.04	0.06
AZ/J&J * Wave 2			0.01	0.03
AZ/J&J * Wave 3			-0.10***	0.03
AZ/J&J * Effectiveness * Wave 2			-0.12	0.09
AZ/J&J * Effectiveness * Wave 3			-0.22**	0.11
AZ/J&J * Safety * Wave 2			0.12	0.09
AZ/J&J * Safety * Wave 3			0.29***	0.10
Constant	0.01	0.01	0.02*	0.01
R^2		0.67		0.68
N		6248		6248

HC2 robust standard errors; * p<0.1, ** p<0.05, *** p<0.01. Note: AZ/J&J = AstraZeneca or Johnson & Johnson treatment.

Table S6. Figure 4 Coefficient Estimates

Covariate =	Age	Anti-intellectualism	Vaccine support	COVID-19 Threat	COVID-19 News	Vaccine Intention
AZ/J&J	-0.02	-0.19***	-0.01	-0.05*	-0.05**	-0.05***
	(0.03)	(0.01)	(0.03)	(0.03)	(0.02)	(0.01)
Covariate	0.00***	-0.66***	0.83***	0.49***	0.07***	0.51***
	(0.00)	(0.03)	(0.02)	(0.02)	(0.00)	(0.01)
AZ/J&J * Covariate	-0.00***	0.17***	-0.17***	-0.13***	-0.03***	-0.12***
	(0.00)	(0.04)	(0.04)	(0.03)	(0.01)	(0.02)
Constant	0.53***	0.95***	0.11***	0.42***	0.52***	0.40***
R^2	0.08	0.16	0.28	0.15	0.09	0.42
N	6247	6248	6248	6248	6248	6248

HC2 robust standard errors in parentheses, * p<0.1, ** p<0.05, *** p<0.01. Note: AZ/J&J = AstraZeneca or Johnson & Johnson treatment.

Table S7. Baseline Vaccination Intention by Covariate Values and Randomly Assigned Vaccine

	Pfizer		Moderna	
	High	Low	High	Low
Age	0.86	0.68	0.82	0.63
Anti-intellectualism	0.57	0.91	0.52	0.88
Support for Childhood Vaccines	0.96	0.48	0.94	0.42
COVID-19 Risk Perceptions	0.86	0.51	0.84	0.40
COVID-19 News Consumption	0.84	0.63	0.79	0.58
Vaccination Intention	0.92	0.42	0.89	0.38
	AstraZeneca		Johnson & Johnson	
	High	Low	High	Low
Age	0.63	0.56	0.72	0.60
Anti-intellectualism	0.44	0.70	0.47	0.79
Support for Childhood Vaccines	0.83	0.40	0.86	0.41
COVID-19 Risk Perceptions	0.66	0.36	0.69	0.38
COVID-19 News Consumption	0.66	0.52	0.71	0.58
Vaccination Intention	0.72	0.33	0.77	0.37

Note: vaccination intention measured on 0-1 scale. Low and high values based on lowest and highest decile in distribution of covariate with exception of age, which is 18/34 vs. 55 and over.
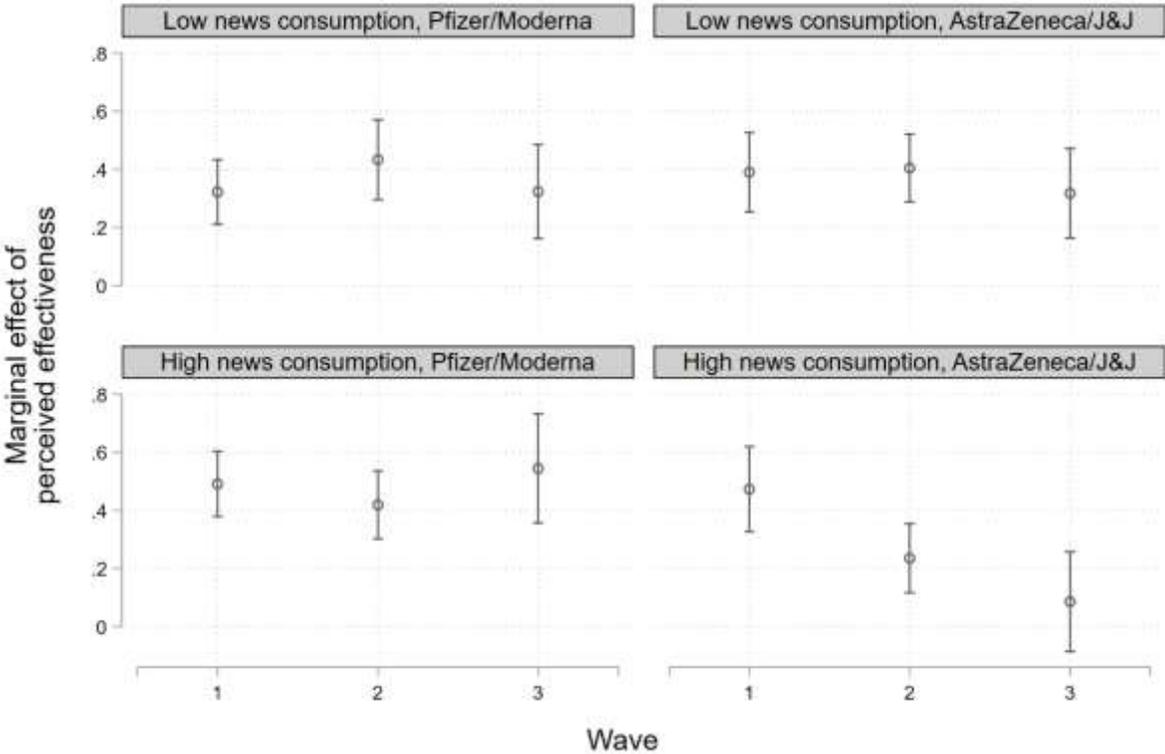
Supplementary Figures

Figure S1. Marginal effect of perceived effectiveness on intention for low- (top) and high-volume (bottom) news consumers in the Pfizer/Moderna (left) or the AstraZeneca/Johnson & Johnson treatment conditions (right). Note: 95% confidence intervals. J&J= Johnson & Johnson.
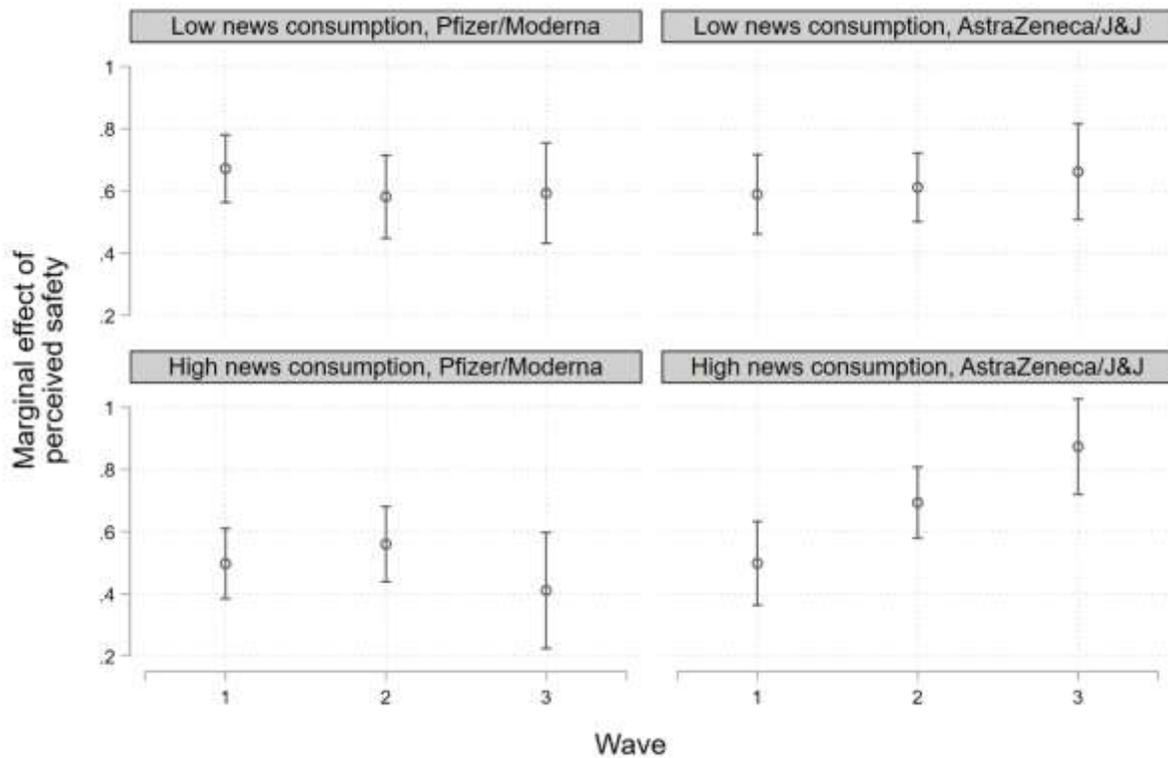
Figure S2. Marginal effect of perceived safety on intention for low- (top) and high-volume (bottom) news consumers in the Pfizer/Moderna (left) or the AstraZeneca/Johnson & Johnson treatment conditions (right). Note: 95% confidence intervals. J&J= Johnson & Johnson.

Path Analysis

Our brand treatment likely affects willingness to take the randomized vaccine by affecting their safety and efficacy evaluations. The communication environment provided information to respondents on the comparative safety and efficacy of the AstraZeneca and Johnson & Johnson vaccines compared to those from Pfizer and Moderna. Random assignment of one vaccine over another will trigger those evaluations and influence their intention. Safety and effectiveness evaluations are therefore a mediating variable between our treatment and outcome.

One common approach to estimate mediations effects is through a path analysis that allows us to tease out the direct influence of our treatment on the outcome from the indirect effects that flow

through the mediating variables. This method is extremely limited in its ability to identify causal effects, even with a randomly assigned treatment. It makes strong assumptions that the outcome variable does not affect the mediators in response to treatment, that there aren't other unmeasured mediators that are affected by the treatment are correlated with the observed mediators, and that there is no measurement error (see Bullock et al. (2010) for a more in-depth treatment).

In this context, for example, it may be possible that people have comparative hesitancy to receive the AstraZeneca and Johnson & Johnson vaccines, which they rationalize by forming opinions on their safety and effectiveness (i.e., X➔Y➔M). Or, the negativity surrounding AstraZeneca and Johnson & Johnson may have caused respondents to hold negatively charged feelings towards these vaccines – an alternative mediator that is correlated with safety and efficacy perceptions. A better approach – though not without its own caveats – is to randomly assign mediating variables as well. We did not believe this was feasible for our purposes: randomizing brand as well as safety and efficacy information would entail a significant and potentially harmful deception.
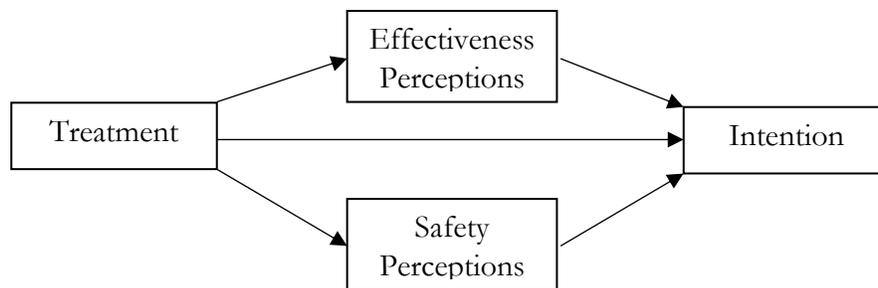

Figure S3. Path Diagram

As a result, we conducted a path analysis using the SEM package in Stata version 16 by estimating the model shown above where the randomized brand treatment could affect intention directly or indirectly through safety and effectiveness perceptions. We allowed for covariation between safety and effectiveness perceptions. The estimates from the path analysis can be found in

Table S8. The treatment is associated with a 0.14 total decrease in intention (on a 0-1 scale) pooling across all three waves (95% CI = -0.16, -0.12; p < 0.001). As expected, over 75% of this effect is felt indirectly through safety and effectiveness perceptions (-0.11; 95% CI = -0.12, -0.09; p < 0.001).

Table S8. Path Analysis Estimates

	Coef.	SE	p-value	95% LB	95% UB
AZ/J&J, Effectiveness	-0.107	0.007	0.000	-0.121	-0.093
AZ/J&J, Safety	-0.107	0.007	0.000	-0.122	-0.093
Effectiveness, Intention	0.374	0.020	0.000	0.335	0.413
Safety, Intention	0.612	0.019	0.000	0.574	0.650
AZ/J&J, Intention (Direct)	-0.035	0.005	0.000	-0.045	-0.025
AZ/J&J, Intention (Indirect)	-0.106	0.007	0.000	-0.119	-0.092
AZ/J&J, Intention (Total)	-0.141	0.009	0.000	-0.158	-0.124

Note: Robust standard errors. AZ/J&J = AstraZeneca or Johnson & Johnson treatment.

Again, we note that these are not causal estimates and should be taken as entirely descriptive. We cannot rule out confounding mediators or endogeneity. That being said, our data is consistent with the notion that safety and efficacy perceptions underlie comparative hesitancy towards the AstraZeneca and Johnson & Johnson vaccines.

<u>References</u>

Bullock, J. G., Green, D. P., & Ha, S. E. (2010). Yes, but what's the mechanism? (Don't expect an easy answer). *Journal of Personality and Social Psychology*, *98*(4), 550–558.

Willingness to Wait Extension

Our analysis shows us that the public does indeed differentiate by vaccine brand. But how intense are these preferences? One way to evaluate this is by asking respondents to make a trade off: get AstraZeneca right away and thus protection from COVID-19, or wait a period of time unprotected for their preferred vaccine. Hesitancy towards AstraZeneca may fade when there is clearly a cost to that hesitancy.

We conducted two additional surveys. The first survey was fielded from April 22-30, 2021 on a sample of 1,441 Canadian citizens 18 years or older using the online panel provider Dynata. The details of the data collection are otherwise identical to the surveys we presented above. We asked respondents to choose between receiving the AstraZeneca or Johnson & Johnson vaccine (randomized) or a vaccine from Pfizer or Moderna (randomized). Respondents could also report that they would not take any COVID-19 vaccine. Among respondents who chose either Pfizer or Moderna, we asked them to imagine they were given a choice between AstraZeneca/Johnson & Johnson or their preferred vaccine after a delay of some number of months. Respondents were asked their choice for a delay of 1 month through to 12 months or more.

We construct a measure to capture the maximum tolerated delay to receive their preferred vaccine. A score of 0 represents those who are unwilling to delay vaccination for their preferred vaccine and opted for AstraZeneca or Johnson & Johnson right away, while a score of 12 indicates a respondent was willing to wait twelve months or more for their preferred vaccine rather than receive AstraZeneca or Johnson & Johnson. A modest number of respondents did not report a consistent preference structure. For instance, they may have reported wanting an immediate vaccination with AstraZeneca or Johnson & Johnson rather than a one month delay for their preferred vaccine, but also report wanting a 12 month delay or more for their preferred vaccine rather than receive AstraZeneca or Johnson & Johnson right away. 17% of respondents in this survey gave inconsistent responses in a similar manner. We exclude these respondents from our analysis as a conservative estimate of the delay people are willing to endure for their preferred vaccine. We provide the results from the full sample in Figure S4.

The second survey was fielded from May 17-28, 2021 on a sample of 1,973 Canadian adults using identical data collection procedures. This survey includes an identical task, but instead of being asked to choose between AstraZeneca/Johnson & Johnson and Pfizer/Moderna vaccines,

respondents were asked to choose between Pfizer and Moderna. Respondents who reported

preferring Pfizer (82% of those with a preference) were asked to report their willingness to get

Moderna immediately or Pfizer after some delay, while the reverse was true for those who reported
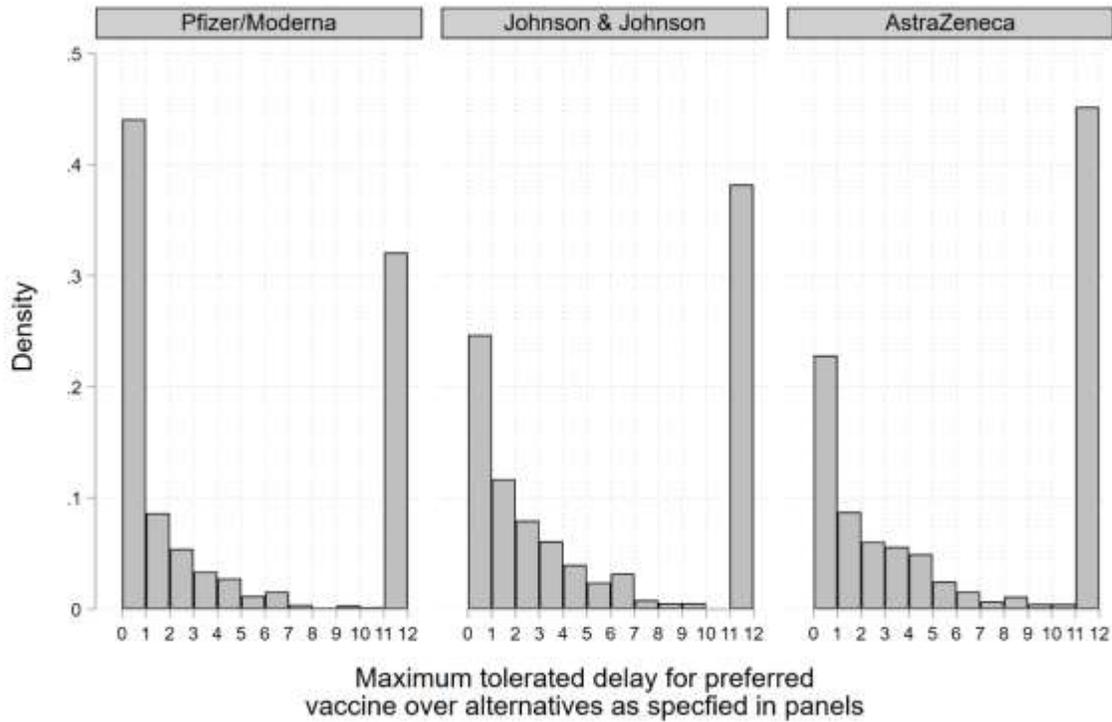
preferring Moderna.

Figure S3. Histogram of maximum tolerated delay for preferred vaccine over Pfizer or Moderna
(Survey 2), Johnson & Johnson (Survey 1), and AstraZeneca (Survey 1).

Figure S3 presents a histogram of the maximum delay tolerated by respondents. It is clear that

brand preferences are relatively intense, and this is particularly true when the choice is between

Pfizer and Moderna on the one hand, or AstraZeneca and Johnson & Johnson, on the other. Only

23% of respondents were willing to take AstraZeneca or Johnson & Johnson immediately, 41%

were willing to wait 12 months or more for their preferred vaccine, while 36% were willing to

tolerate some intermediate delay. These differences are not as stark when respondents were asked to

choose between Pfizer and Moderna. 43% were willing to take their less preferred vaccine

immediately, while 32% reported a willingness to wait 12 months or more and 24% were willing to tolerate some intermediate delay. Importantly, even if our time experiment calibrates only coarsely to actual time preferences, we do see important differences across vaccines, suggesting that however long individuals would actually be willing to wait, it is longer when offered Astra Zeneca or Johnson and Johnson.
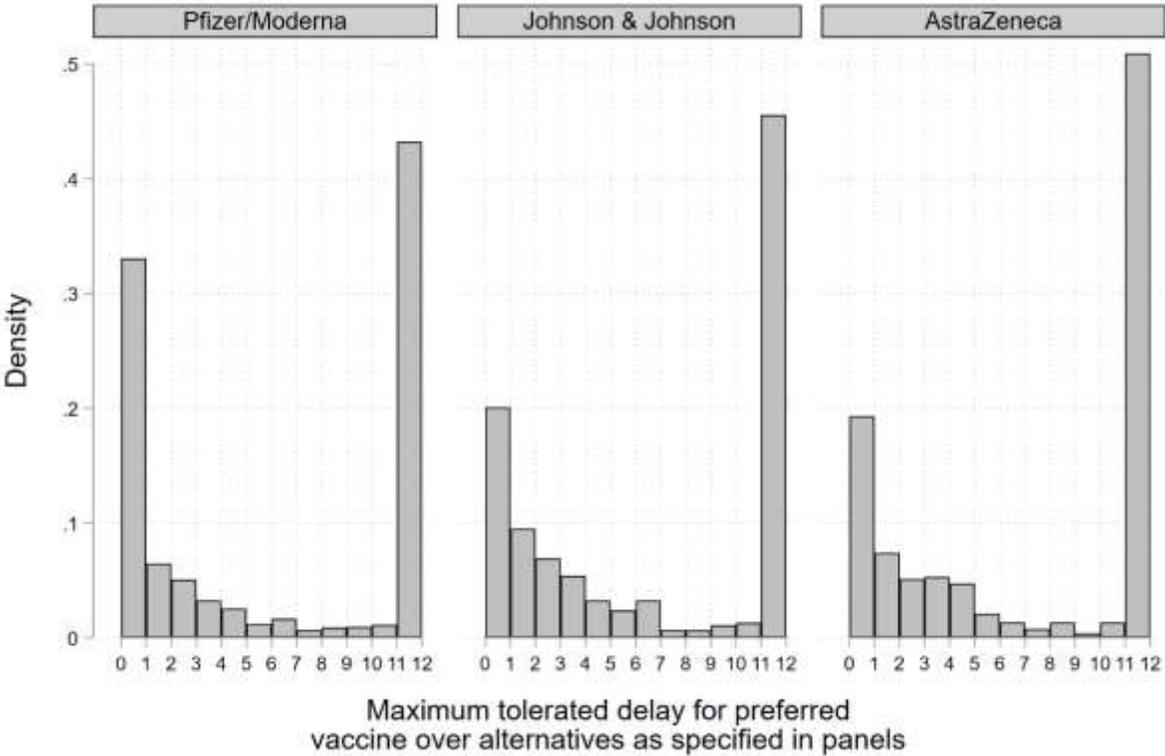

Figure S4. Histogram of maximum tolerated delay for preferred vaccine over Pfizer or Moderna (Survey 2), Johnson & Johnson (Survey 1), and AstraZeneca (Survey 1). All respondents.